DATA
STREAM
PAYLOAD
10

11

19 — MEDIUM
CONDITIONS
SENSORS

TO/FROM
CONTROLLER 26

SIGNAL
CONDITIONER

12 — TRANSMITTER

13 → FREE
SPACE
MEDIUM

14 — RECEIVER

15 — SIGNAL
EXTRACTOR
DECODE
DE-INTERLEAVE

TO END
USE
VIDEO
DATA

FIG. 1

FIG. 2

The following text appears within the figure:

10 → 2.5 GBIT PAYLOAD

20 REED-SOLOMON ENCODER

2.86 GBIT ENCODED STREAM

21 60-BIT INPUT SHIFT REGISTER (4-DEEP FIFO)

SENSORS 19 / LINK

26 COMPUTER CONTROLLER

TO OUTPUT SHIFT REGISTER 25

TO FPGA ADDRESS GENERATORS 23, 24

TO SDRAM DEVICES

24 FPGA ADDRESS GENERATOR

FROM CONTROLLER 26

22h FOUR 16 BIT x 8 MEGAWORD 133 MHz @ CL2 SDRAMs

22a FOUR 16 BIT x 8 MEGAWORD 133 MHz @ CL2 SDRAMs

22

23 FPGA ADDRESS GENERATOR

FROM CONTROLLER 26

25 OUTPUT SHIFT REGISTER (4-DEEP FIFO) → TO TRANSMITTER 12

FROM CONTROLLER 26

11

CODEWORD:
LENGTH = n

30

BURST ERROR: LENGTH E

ENCODED DATA
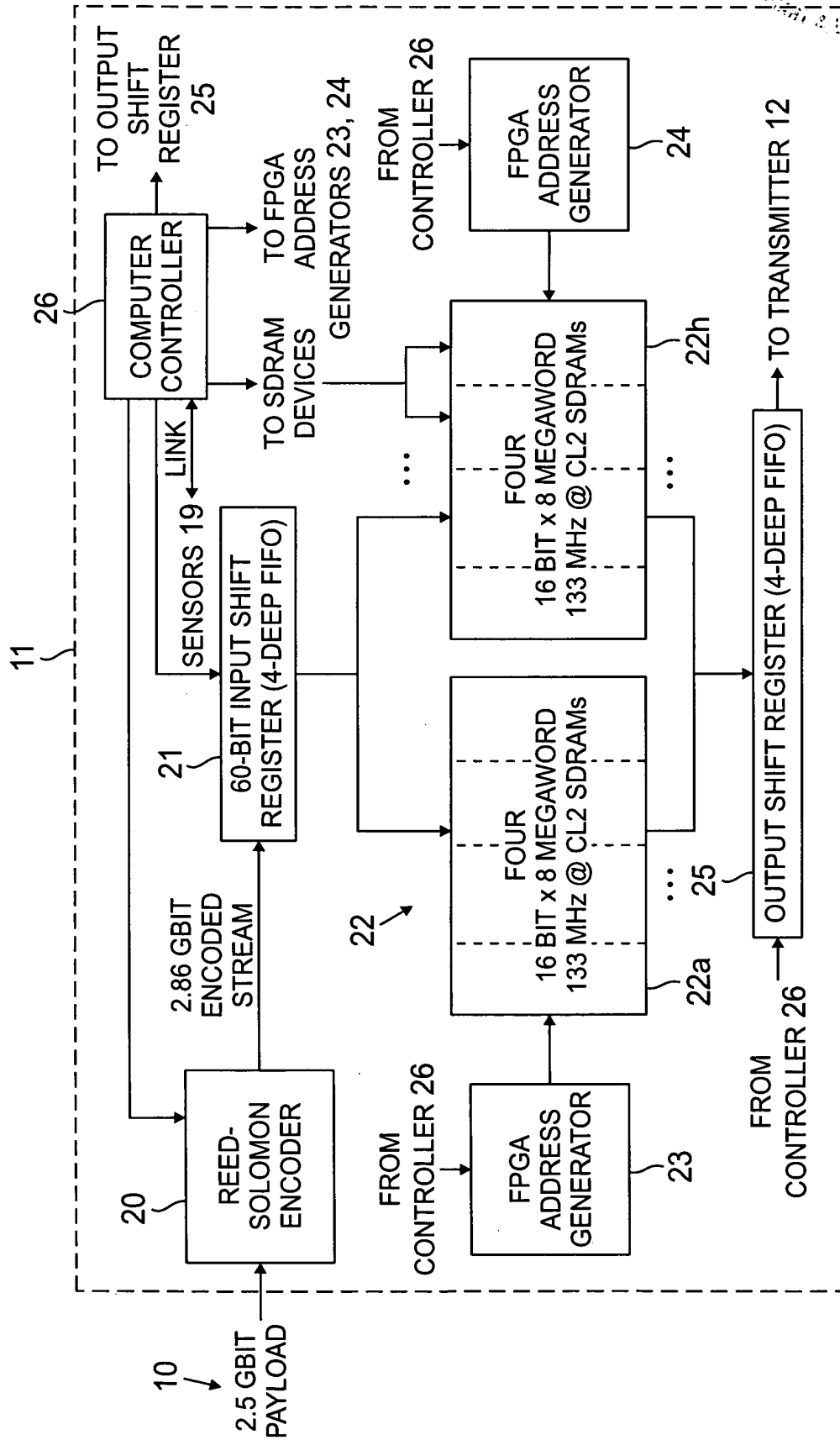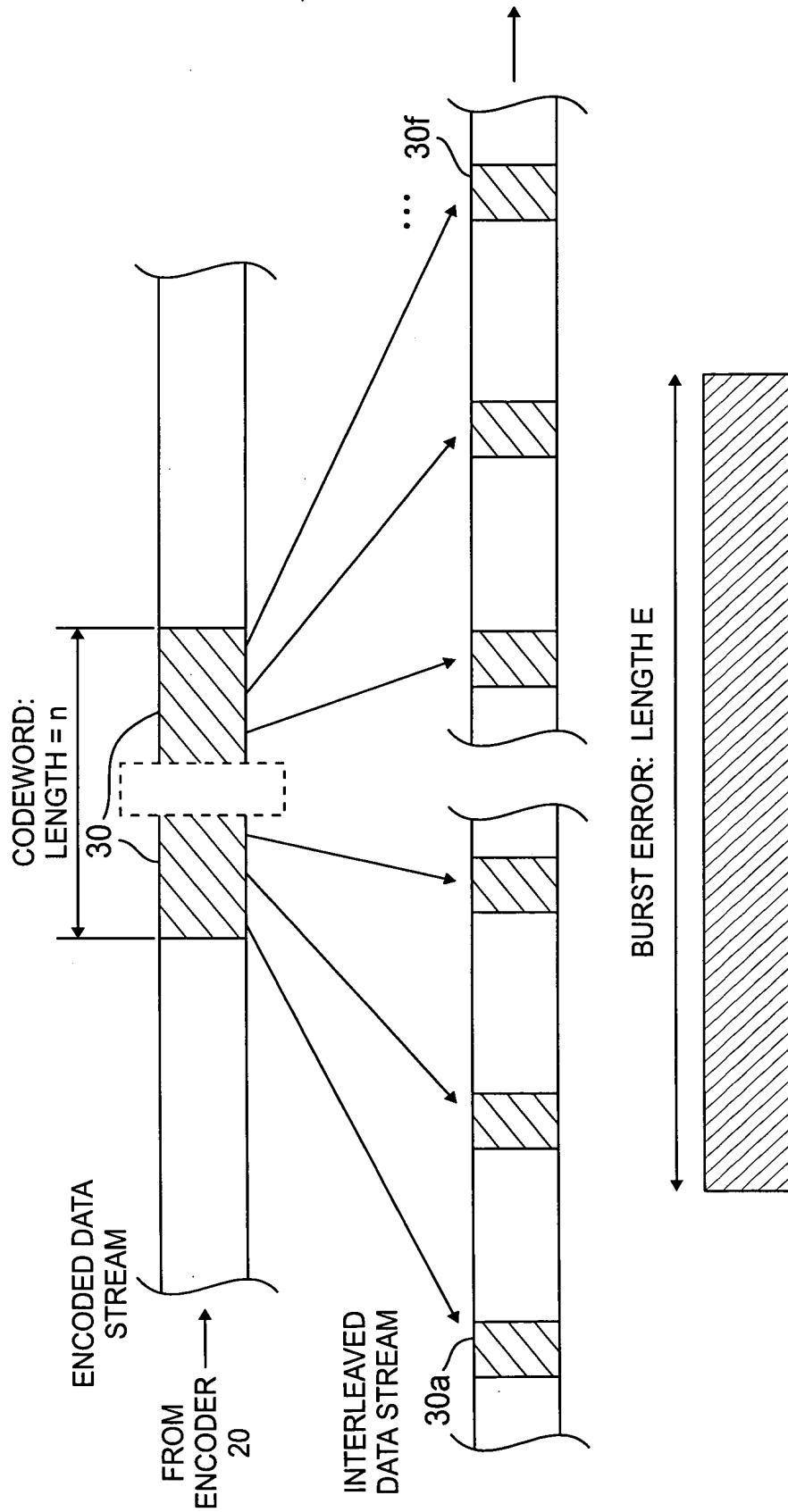STREAM

FROM
ENCODER
20

INTERLEAVED
DATA STREAM

30a

30f

INTERLEAVING THE ENCODED PAYLOAD

FIG. 3

FROM REED-SOLOMON ENCODER 20

DENOTE THE 60 BIT SEGMENTS OF
THE CODEWORDS BY A 2-TUPLE:

(n, m): n = CODEWORD NUMBER; m = 60-BIT
SEGMENT WITHIN THE CODEWORD
INDICATED
n = 1, 2, ..., 156250
m = 1, 2, ..., 34 FOR 2040 CODEWORD
LENGTH

INTERLEAVE THE FIRST BLOCK
OF 156,250 CODEWORDS

THEN, AFTER INTERLEAVING THE FIRST BLOCK
OF 156,250 CODEWORDS THE SEQUENCE IS:

[1,1 2,1 3,1 ..... 156250,1] [1,2 2,2 ..... 156250,2] ..... [1,34 2,34 ... 156250,34]

INTERLEAVE THE SECOND
BLOCK OF 156,250 CODEWORDS

·
·
·
·

COMPLETE
INTERLEAVING

FIG. 4

FIG. 5

(VIRTUAL PAGES ARE 15 WORDS IN LENGTH)

PHYSICAL PAGE 1

| 1,1 | | 1,2 | | 1,34 |
| 2,1 | ... 15,1 | 2,2 | ... 15,2 | 2,34 ... 15,34 |

0
...
14

156250

156250 + 15

33 × 156250

PHYSICAL PAGE 2

| 16,1 | | 16,2 | | 16,34 |
| 17,1 | ... 30,1 | 17,2 | ... 30,2 | 17,34 ... 30,34 |

15

156250 + 15

33 × 156250 + 15

PHYSICAL PAGE 10417

156241,1		156241,2		156241,34
156242,1	...	156242,2	...	156242,34
156250,1		156250,2		156250,34

156240

156250 + 15 × 10416

33 × 156250 + 10416 × 15
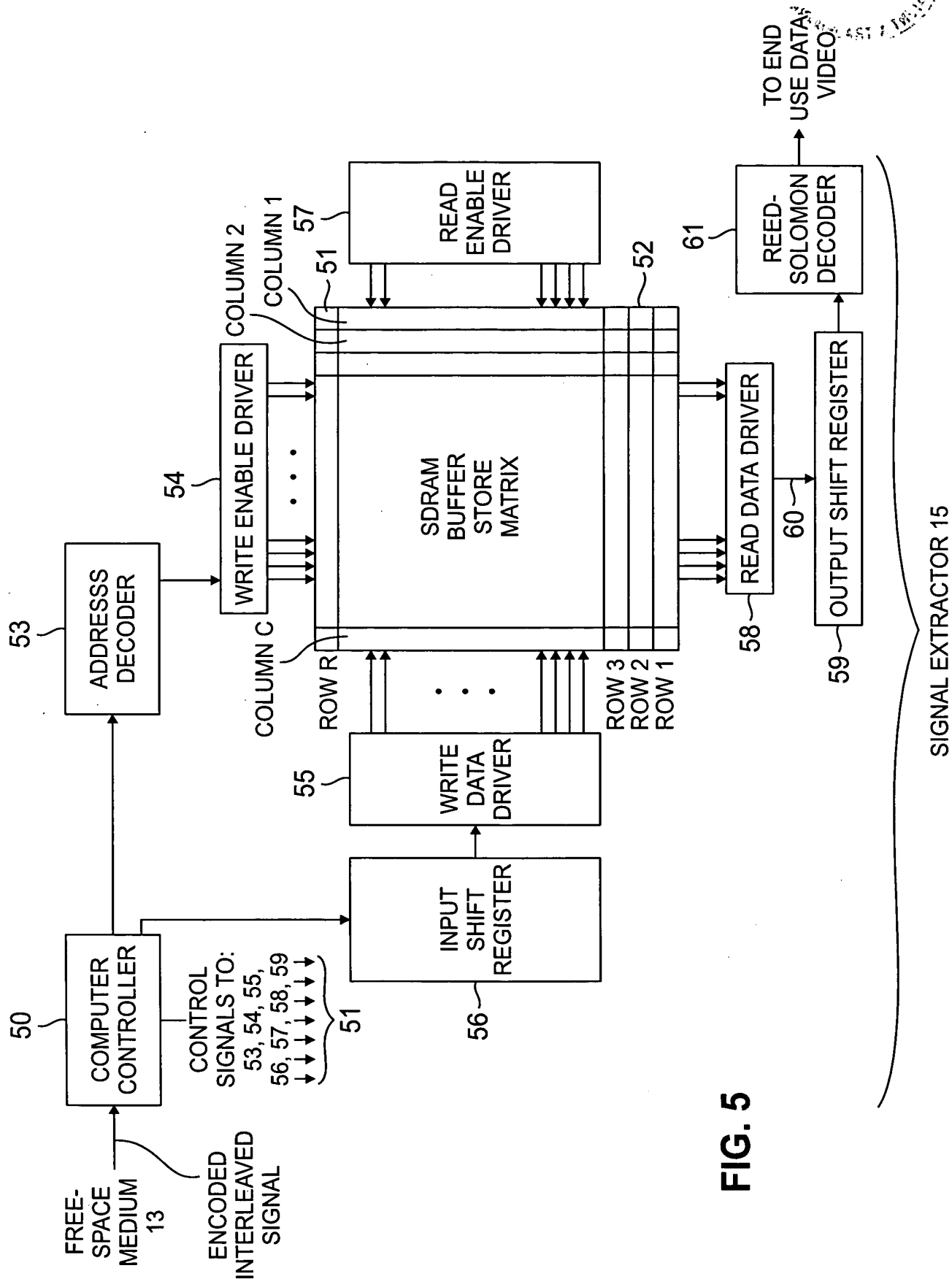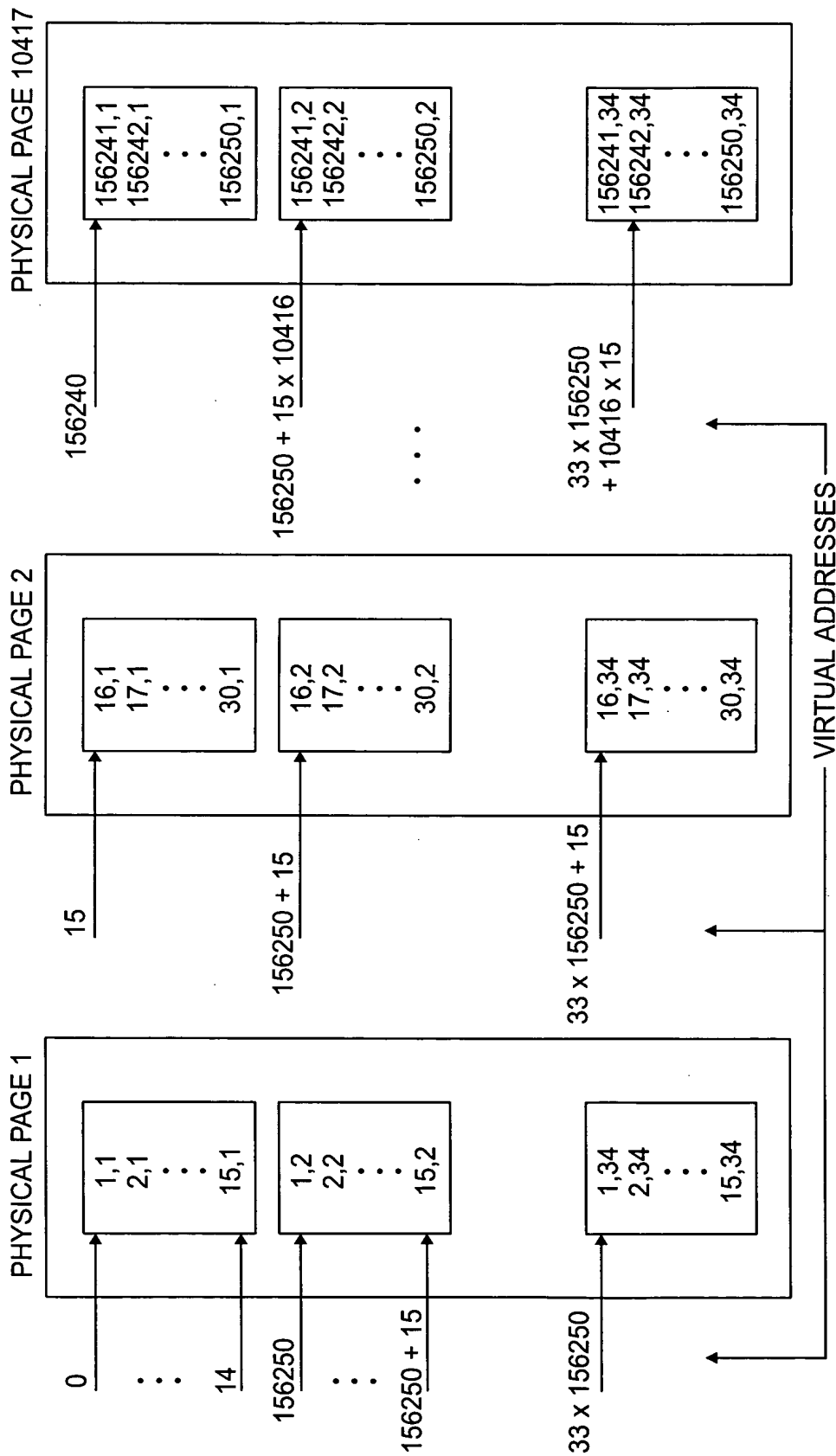
VIRTUAL ADDRESSES

REMAPPING ADDRESSES TO BALANCE "READ" VS. "WRITE" OVERHEAD IN TERMS OF SDRAM PAGE CHANGES

FIG. 6A

SUCCESSIVE ADDITIONAL (APPROX. 10,416) SUB-MATRICES MAPPING FURTHER 60-BIT ENTRIES INTO SDRAM PAGES TO STORE SECOND THROUGH m^{th} CODEWORDS DURING WRITE OPERATION

SUB-MATRIX MAPPING 60-BIT ENTRIES INTO FIRST DRAM PAGE OF 512 ADDRESSES, USING 510 MATRIX CELLS TO STORE FIRST CODEWORD DURING WRITE OPERATION

SDRAM BUFFER STORE 22

156250,1
156250,2
156250,34

16,1 .... 16,2 .... 16,34 ....

27

15,1 .... 15,2 .... 15,34 ....

1,1 2,1 3,1 ....
1,2 2,2 3,2 ....
1,34 2,34 3,34 ....
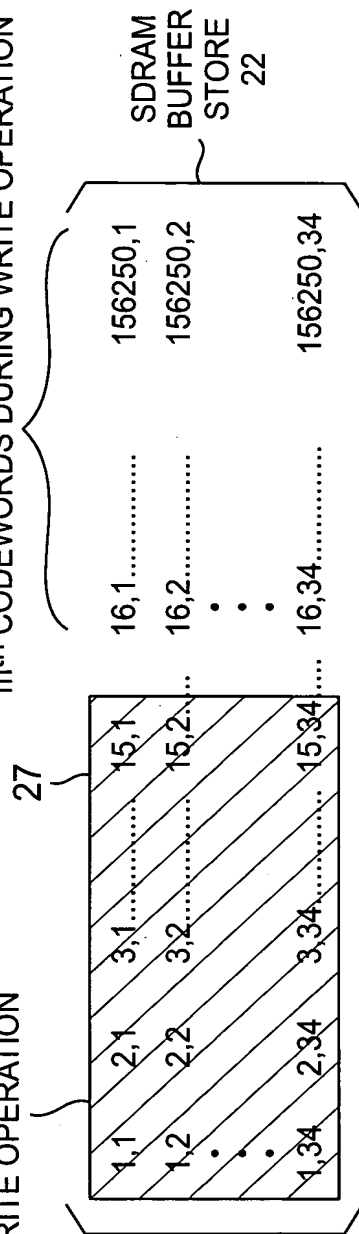
CODEWORD SEGMENTS EXPRESSED AS A MATRIX

FIG. 6B

IF RECEIVED WERE STORED SEQUENTIALLY AT THE RECEIVER A PHYSICAL PAGE CHANGE WOULD REQUIRED EVERY MEMORY REFERENCE TO COMPLETE THE DE-INTERLEAVING

SDRAM BUFFER STORE 52

156250,1
156250,2
156250,34

513,1 .... 513,2 513,34

512,1 512,2 .... 512,34 512,34

1,1 2,1 3,1 ....
1,2 2,2 3,2 ....
1,34 2,34 3,34 ....
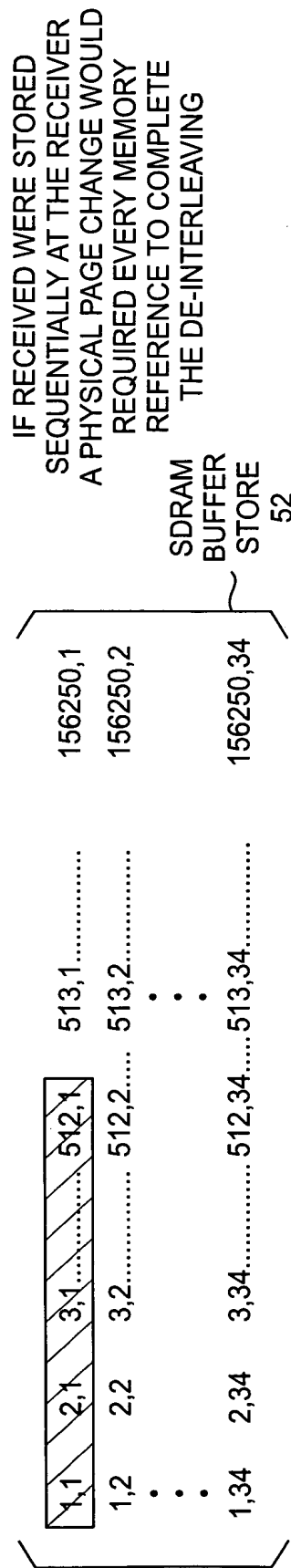
CROSS-HATCHED SUBMATRIX INDICATES SEGMENT OF RECEIVED MATRIX THAT WOULD BE HELD ON ONE 512 ADDRESS PAGE IF RECEIVER STORED ENTRIES SEQUENTIALLY

FIG. 6C

PROVIDE TRANSMISSION PAYLOAD DATA BIT-STREAM

ARE CONDITIONS PRESENT IN TRANSMISSION MEDIUM WHICH CAUSE SCINTILLATION EFFECTS ? — NO

YES

ACTIVATE ENCODING AND INTERLEAVING

ENCODE TRANSMISSION PAYLOAD DATA BIT-STREAM INTO CODEWORDS IN REED-SOLOMON ENCODER

FRAGMENT EACH SAID CODEWORD INTO SEGMENTS

PROVIDE SDRAM BUFFER STORE MATRIX OF MEMORY CELLS WITH PAGE SIZE P AND CAPACITY TO CORRECT ERROR BURST OF 20 MILLION BITS IN PAYLOAD DATA STREAM

DETERMINE AN X-Y SUBMATRIX OF SAID CELLS REPRESENTING THE SET OF SDRAM CELL ENTRIES FOR CONTAINING A SINGLE SDRAM PHYSICAL PAGE OF SIZE P

DOES PAGE-CHANGE OVERHEAD COST OF WRITE OPERATION TO SDRAM BUFFER STORE EXCEED PAGE-CHANGE OVERHEAD COST OF READ OPERATION FOR PAGE ? — NO

YES

REDISTRIBUTE PAGE CHANGE OVERHEAD OPERATIONS FROM WRITE OPERATION TO READ OPERATION

WRITE-INTERLEAVE SEGMENTS TO SUCCESSIVE SETS OF SUBMATRIX CELLS, EACH SET HAVING K CONSECUTIVE COLUMN ENTRIES FOR PAGE SIZE P

REMAP CELL ADDRESSES SO THAT READ OUT FROM SAID MATRIX REPLICATES CONTENTS OF SUCCESSIVE SETS OF SUBMATRIX CELLS

DURING READ OPERATION CHANGE PAGES WITH FREQUENCY DETERMINED BY K

WRITE-INTERLEAVE CORRESPONDING SEGMENTS OF SUCCESSIVE CODEWORDS INTO SUCCESSIVE SETS OF SUBMATRIX CELLS AND READ OUT CONTENTS OF CELLS BY ROW

APPLY OUTPUT TO TRANSMISSION CHANNEL

FIG. 7A   FLOW CHART OF PROCESS AT TRANSMITTER END

RECEIVE TRANSMISSION PAYLOAD DATA BIT-STREAM

NO ⟨ IS DATA BIT-STREAM ENCODED AND INTERLEAVED ? ⟩

YES

ACTIVATE DEINTERLEAVING AND DECODING

ROUTE TRANSMISSION PAYLOAD DATA BIT-STREAM TO SDRAM BUFFER STORE MATRIX OF MEMORY CELLS SUBSTANTIALLY IDENTICAL TO TRANSMIT-END SDRAM BUFFER STORE

DETERMINE THE X-Y SUBMATRIX OF MEMORY CELLS THAT CONSTITUTE THE SET OF SDRAM CELL ENTRIES AT THE TRANSMIT END FOR CONTAINING A SINGLE SDRAM PHYSICAL PAGE SIZE P

⟨ DOES PAGE-CHANGE OVERHEAD COST OF WRITE OPERATION TO RECEIVE-END SDRAM BUFFER STORE EXCEED PAGE-CHANGE OVERHEAD COST OF READ OPERATION FOR PAGE ? ⟩ NO

YES

WRITE-INTERLEAVE CORRESPONDING SEGMENTS OF SUCCESSIVE CODEWORDS INTO SUCCESSIVE SETS OF SUBMATRIX CELLS AND READ OUT CONTENTS OF CELLS BY ROW

REDISTRIBUTE PAGE CHANGE OVERHEAD OPERATIONS FROM WRITE OPERATION TO READ OPERATION:

WRITE-INTERLEAVE SEGMENTS TO SUCCESSIVE SETS OF SUBMATRIX CELLS, EACH SET HAVING K CONSECUTIVE COLUMN ENTRIES FOR PAGE SIZE P

REMAP CELL ADDRESSES SO THAT READ OUT FROM SAID MATRIX WILL REPLICATE CONTENTS OF SUCCESSIVE SETS OF SUBMATRIX CELLS

DURING READ OPERATION CHANGE PAGES WITH FREQUENCY DETERMINED BY K

APPLY READ OUTPUT TO REED-SOLOMON DECODER

APPLY OUTPUT OF REED-SOLOMON DECODER TO USER DEVICE

SEND DATA-BIT STREAM TO USER DEVICE

USER DEVICE

FLOW CHART OF PROCESS AT RECEIVER END

FIG. 7B